# Trans-Lake Washington Project

# High Capacity Transit Modal Evaluation Transportation, Environmental, and Cost Findings

Prepared for

**Washington State Department of Transportation**
**Office of Urban Mobility**
401 Second Avenue South, Suite 300
Seattle, Washington 98104

**Sound Transit**
401 South Jackson Street
Seattle, Washington 98104

Prepared by

**Trans-Lake Washington Project Team**

Parametrix, Inc.
CH2M HILL
Parsons Brinckerhoff
EnviroIssues
Puget Sound Transit Consultants

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# TABLE OF CONTENTS

# 2. TRANSPORTATION EFFECTIVENESS

## 2.1 EFFECTIVENESS EVALUATION CRITERIA

At the Modal Analysis stage, the focus of the evaluation was on criteria that reflected critical differences in transportation performance among HCT alternatives. The three mobility criteria used in evaluating the HCT alternatives in the Modal Analysis were:

- Transit Ridership across Lake Washington

  Ridership is a primary indicator of the attractiveness of a transit service or services. Ridership forecasts across Lake Washington specifically addressed the attractiveness of trips by transit between Seattle and the east side communities.

- High Capacity Transit Boardings

  This criterion provided insight to the total number of riders using the Trans-Lake HCT alternatives, as well as the effectiveness of the HCT alternatives in serving trips internal to both Seattle and the east side communities.

- Travel Time

  Travel time is a measure of convenience and quality of service for HCT patrons.

The remaining transportation criteria involve highway facility factors (mode split, Vehicle Miles of Travel [VMT]), Person-Hours of Travel, etc.). These will be applied during the multi-modal alternatives analysis.

Sound Transit's EMME/2 regional model was used to calculate data for the ridership and boarding criteria. Travel time was estimated using a calibrated spreadsheet model for vehicle run times, taking into account typical vehicle operating speeds, vehicle acceleration and deceleration, as well as dwell and transfer times.

## 2.2 TRANSIT RIDERSHIP ACROSS LAKE WASHINGTON

### 2.2.1 Ridership Forecasts

Table 2-1 is summary table of the range of EMME/2 model results for 2020 daily and PM peak period total Trans-Lake ridership, for each HCT corridor. The PM Peak period covered the hours from 3:00 to 6:00 p.m. The total ridership included passengers using all types of transit services across the lake, including HCT. All of the forecast results, even "No Action", include the assumption that the Central Link line would be complete between Everett and Tacoma by the year 2020.

## Table 2-1. Transit Ridership Summary Table

| Corridor Alternative | Range of Forecasted 2020 Trans-Lake Transit Ridership (2-Way) | |
|---|---|---|
| | Daily | PM Peak Period |
| No Action | 40,000 | 15,000 |
| C1: SR 520 Fixed Guideway Alternatives | 51,000-55,000 | 18,000-20,000 |
| C1: SR 520 Bus Rapid Transit Alternatives | 54,000-55,000 | 21,000 |
| C2: I-90 Fixed Guideway Alternatives | 46,000-52,000 | 17,000-20,000 |
| C3: Mid-Lake Fixed Guideway Alternative | 49,000 | 21,000 |

Table 2-2 below provides a more detailed breakdown of the total transit ridership across Lake Washington (west of Mercer Island, in the case of I-90) for the daily and PM peak periods, summed over SR 522, SR 520, I-90, and a Mid-Lake crossing, where proposed.

## Table 2-2. 2020 Transit Trips across Lake Washington

| Alternative | Description | Daily Cross-Lake Transit Ridership (2-Way) | PM Peak Period Cross-Lake Transit Ridership | | | Percentage Daily Ridership during PM Peak period |
|---|---|---|---|---|---|---|
| | | | Eastbound | Westbound | Total (2-Way) | |
| **No Action** | No Trans-Lake HCT Facilities | 39,700 | 9,200 | 6,300 | 15,500 | 39% |
| **SR 520 Fixed Guideway Alternatives** | | | | | | |
| C1.1a | SR 520 Fixed Guideway, Downtown Seattle - Bellevue - Kirkland/Redmond | 50,600 | 10,700 | 8,000 | 18,700 | 37% |
| C1.1b | SR 520 Fixed Guideway, Downtown Seattle - University District - Bellevue - Kirkland/ Redmond | 55,300 | 10,750 | 9,600 | 20,350 | 37% |
| C1.1c | SR 520 Fixed Guideway, Downtown Seattle - University District - Kirkland/Redmond/ Bellevue | 51,000 | 10,050 | 8,850 | 18,900 | 37% |
| C1.1d | SR 520 Fixed Guideway, Downtown Seattle - Ballard - University District - Kirkland/ Redmond/ Bellevue | 49,500 | 9,600 | 8,850 | 18,450 | 37% |
| **SR 520 Bus Rapid Transit Alternatives** | | | | | | |
| C1.2a | SR 520 BRT, Radial Service Pattern, Pacific Street Intercept | 55,200 | 11,200 | 10,300 | 21,500 | 39% |
| C1.2b | SR 520 BRT, Radial Service Pattern, Westlake Intercept | 53,500 | 11,300 | 9,300 | 20,600 | 39% |
| C1.2c | SR 520 BRT, Trunk/Feeder Service Pattern, Direct Routing through Downtown Seattle | 54,200 | 11,450 | 9,250 | 20,700 | 38% |

## Table 2-2 2020 Transit Trips Across Lake Washington (Continued)

| Alternative | Description | Daily Cross-Lake Transit Ridership (2-Way) | PM Peak Period Cross-Lake Transit Ridership | | | Percentage Daily Ridership during PM Peak period |
|---|---|---|---|---|---|---|
| | | | Eastbound | Westbound | Total (2-Way) | |
| **I-90 Fixed Guideway Alternatives** | | | | | | |
| C2.1a | I-90 Fixed Guideway, Downtown Seattle - Factoria - Issaquah/ Bellevue - Kirkland/Redmond | 45,500 | 9,300 | 7,500 | 16,800 | 37% |
| C2.1b | I-90 Fixed Guideway, Downtown Seattle - Bellevue - Kirkland/ Redmond | 51,400 | 11,050 | 8,550 | 19,600 | 38% |
| **Mid-Lake Fixed Guideway Alternative** | | | | | | |
| C3.1a | Mid-Lake Fixed Guideway, Downtown Seattle - Bellevue - Kirkland/Redmond | 49,000 | 11,300 | 9,500 | 20,800 | 42% |

### 2.2.2 Comparison of Alternatives: Ridership

Introduction of a Trans-Lake HCT system will increase 2020 daily transit ridership across the lake by 5,800 to 15,600 people, or by 15 to 40%. Ridership during the PM peak period is expected to increase by about 1,300-6,000 people, or between 12 and 39% compared to the "No Action" alternative. Between 39% and 42% of daily travel by transit across Lake Washington is forecasted to occur during the 3-hour afternoon peak period.

The variation among the three primary corridors in terms of ridership is relatively small, considering their significant route differences. This result is not entirely surprising, however, since every alternative serves the major travel markets of Downtown Seattle, Bellevue, Kirkland, and Redmond.

#### *2.2.2.1 SR 520 Fixed Guideway Alternatives*

Alternative C1.1a, with a direct connection to Downtown Seattle, is forecasted to have the lowest daily cross-lake ridership of the SR 520 corridor alternatives. Alternative C1.1b, which serves new west side travel markets in Seattle, is expected to have about 9% higher daily and PM Peak Period ridership compared to C1.1a due to increased off-peak direction travel. The second, northerly connection to Central Link (via a transfer at Pacific Street Station) coupled with the longer west side alignments (serving the relatively dense neighborhoods of the University District, Wallingford, Fremont, and east Queen Anne) result in increased westbound cross-lake ridership in the afternoon peak period and off-peak periods. This additional ridership is generated by the improved access for west side residents to employment opportunities in the SR 520 corridor, and to communities on the east side of Lake Washington. Alternative C1.1b, which has the most direct connection to Downtown Bellevue on the east side coupled with a west side alignment serving the University District, Wallingford, Fremont and east Queen Anne exhibits the highest westbound PM peak period cross-lake ridership.

Alternative C1.1c, which is similar to C1.1b except for an indirect Downtown Bellevue connection, has similar PM Peak Period ridership but somewhat lower daily ridership than C1.1b. In fact, the cross-lake daily ridership is almost the same as for C1.1a even though new west side travel markets are served. Although it introduces new access opportunities for west side residential areas to eastside employment areas, it increases travel times between major centers. With reduced accessibility between Downtown Bellevue and west side neighborhoods, somewhat lower off-peak period and off-peak direction ridership is anticipated.

Alternative C1.1d, which serves more west side markets than C1.1c, has lower daily cross-lake ridership than all the other SR 520 Fixed Guideway alternatives. It also has the lowest PM Peak Period, peak direction ridership. This is due to indirect connections both to Downtown Seattle on the west side and Downtown Bellevue on the east side, which increased travel time and made the alternative less competitive.

In terms of cross-lake transit ridership alone, Alternative C1.1b, with access to new west side markets and a direct connection to Downtown Bellevue, performs best. However, cross-lake

ridership differences between the SR 520 Fixed Guideway Alternatives C1.1a and C1.1c are not considered significant. However, Alternative C1.1d is clearly the least preferred alternative from a cross-lake ridership perspective.

#### *2.2.2.2 SR 520 BRT Alternatives*

The BRT ridership forecasts are almost exactly the same for all three BRT alternatives, and are among the highest reported in Table 2-2. The BRT alternatives perform well as a result of the modeling assumptions that (1) travel times for BRT alternatives with exclusive busways would be very similar to those associated with Fixed Guideway alternatives, and (2) that BRT service would also be provided in the I-90 corridor as well as the SR 520 corridor. The model results show that there is no clear preference for one alternative based upon the cross-lake ridership criterion alone.

Alternative C1.2a, with the Pacific Street Intercept, has slightly higher reverse commute cross-lake ridership, again due to the increased attractiveness of east side employment centers for west side residents. However, the key operational concern with this alternative is the ability of the Central Link line to handle passenger demand between Pacific Street and Downtown Seattle if passengers from the north and transfers from the east must be accommodated. This intercept option eventually would require increased Central Link train frequency between the University District and Downtown Seattle. Such an increase could be limited by capacity constraints on Central Link, and construction of an additional HCT connection to Downtown Seattle from the SR 520 corridor may be needed.

Another operational issue with BRT Alternatives C.1.2b and C1.2c is on-street capacity. The operating scenario assumes that BRT vehicles will be able to mix with general purpose traffic in the University District and Downtown Seattle, and that congestion will not be extensive. This assumption was made because future north and south extensions of Central Link have the potential to significantly reduce on-street bus volumes in these areas; however, the assumption should be carefully checked and the impact of congestion on BRT service as well as the impact of BRT vehicles mixing with general traffic must be clearly understood.

#### *2.2.2.3 I-90 Fixed Guideway Alternatives*

The I-90 corridor is expected to generate slightly lower daily and PM peak period ridership than the SR 520 corridor alternatives, since the alignment alternatives do not serve new west side markets. The two I-90 Fixed Guideway alternatives have the most significant variation in cross-lake ridership of all the alternatives within each corridor grouping. Alternative C2.1b is projected to result in both higher daily and PM peak period ridership than C2.1a, by approximately 13% and 17%, respectively. The poor performance of C2.1a relative to C2.1b is a result of its indirect connection to Downtown Bellevue via Factoria. In addition, the Issaquah branch line proposed in Alternative C2.1a does not generate as much additional cross-lake ridership as it loses due to longer travel times to Bellevue. This finding indicates that total transit ridership would be better served by providing a faster connection to Bellevue and running an express bus route to Issaquah with a transfer to rail at South Bellevue, as proposed in Alternative C2.1b. Alternative C2.1b is clearly the best performer from a cross-lake ridership perspective.

#### *2.2.2.4 Mid-Lake Alternative*

The Mid-Lake Alternative C3.1a is expected to have the second-lowest daily cross-lake ridership, while the PM peak period ridership would be very similar to the other alternatives. The Mid-Lake crossing has fewer off-peak period transit trips, particularly when compared to the SR 520 corridor alternatives. About 42% of total daily cross-lake trips are expected to occur during the afternoon period, compared to 37-39% with the other alternatives. This finding results from two characteristics of the Mid-Lake direct Downtown Seattle to Downtown Bellevue alignment:

- The alignment does not serve the transit market areas just south of Downtown Bellevue as directly as the I-90 alternatives
- The alignment does not serve the University District and new west side markets as do a number of the SR 520 Fixed Guideway options.

## 2.3 HCT BOARDINGS

### 2.3.1 Boarding Forecasts

Table 2-3 is a summary table listing the forecasted range of daily regional HCT boardings resulting from implementation of HCT within each of the corridors under consideration. These boardings are in addition to those associated with the extension of the Central Link light rail north to Everett and south to Tacoma. Completion of this north-south line as per the Sound Transit Long Range Vision is expected to result in over 250,000 daily rail boardings between Everett and Tacoma by 2020, without a Trans-Lake HCT system in place.

**Table 2-3. HCT Boardings Summary Table**

| Corridor Alternative | Range of Increases to 2020 System-Wide Daily HCT Boardings [1] |
|---|---|
| C1: SR 520 Fixed Guideway Alternatives | 50,000-100,000 |
| C1: SR 520 Bus Rapid Transit Alternatives | 47,000-53,000 |
| C2: I-90 Fixed Guideway Alternatives | 51,000 |
| C3: Mid-Lake Fixed Guideway Alternative | 44,000 |

[1] In addition to forecasted boardings of over 250,000/day for "No Action", which includes extensions of the Central Link line to Everett and Tacoma.

Table 2-4 provides a more detailed breakdown of the daily transit boardings generated by each of the Trans-Lake HCT alternatives, by west side and east side boardings.

**Table 2-4. 2020 System-Wide Daily HCT Boardings**

| Alternative | Description | West Side Boardings | East Side Boardings | Total Boardings |
|---|---|---|---|---|
| **SR 520 Fixed Guideway Alternatives** | | | | |
| C1.1a | SR 520 Fixed Guideway, Downtown Seattle - Bellevue - Kirkland/Redmond | 27,300 | 22,700 | 50,000 |
| C1.1b | SR 520 Fixed Guideway, Downtown Seattle - University District - Bellevue - Kirkland/Redmond | 55,600 | 25,800 | 81,400 |
| C1.1c | SR 520 Fixed Guideway, Downtown Seattle - University District - Kirkland/Redmond/Bellevue | 53,200 | 32,800 | 86,000 |
| C1.1d | SR 520 Fixed Guideway, Downtown Seattle - Ballard - University District - Kirkland/Redmond/Bellevue | 69,100 | 31,300 | 100,400 |
| **SR 520 BRT Alternatives** | | | | |
| C1.2a | SR 520 BRT, Radial Service Pattern, Pacific Street Intercept | 20,700 | 26,400 | 47,100 |
| C1.2b | SR 520 BRT, Radial Service Pattern, Westlake Intercept | 19,100 | 31,200 | 50,300 |
| C1.2c | SR 520 BRT, Trunk/Feeder Service Pattern, Direct Routing through Downtown Seattle | 18,700 | 34,800 | 53,500 |
| **I-90 Fixed Guideway Alternatives** | | | | |
| C2.1a | I-90 Fixed Guideway, Downtown Seattle - Factoria - Issaquah/Bellevue - Kirkland/Redmond | 17,600 | 33,800 | 51,400 |
| C2.1b | I-90 Fixed Guideway, Downtown Seattle - Bellevue - Kirkland/Redmond | 21,700 | 29,800 | 51,500 |
| **Mid-Lake Fixed Guideway Alternative** | | | | |
| C3.1a | Mid-Lake Fixed Guideway, Downtown Seattle - Bellevue - Kirkland/Redmond | 18,800 | 25,600 | 44,400 |

Note: Mercer Island boardings have been included in the east side total. Transfers between the Central Link line and Trans-Lake HCT alternatives are not included in the table.

## 2.3.2 Comparison of Alternatives: HCT Boardings

### *2.3.2.1 SR 520 Fixed Guideway Alternatives*

Fixed Guideway Alternative C1.1a, with a direct connection between Downtown Seattle and Downtown Bellevue, has very similar total daily boarding projections compared to Fixed Guideway Alternative C1.2b and BRT Alternative C2.1b, which also have direct connections.

The impact of serving new residential west side markets, however, is dramatic when the total number of west side boardings associated with C1.1a is compared with that of Alternatives C1.1b-d, which have the highest west side and daily boardings of all the HCT alternatives. On the west side of the lake, when the new travel markets of the University District, Wallingford, Fremont, Ballard and Queen Anne are serviced by the SR 520 Fixed Guideway alternatives, the number of daily boardings could be up to double the number of daily transit passengers compared to Alternative C1.1a with a direct Downtown Seattle alignment, and up to double the cross-lake ridership. This result illustrates the presence of a substantial intra-Seattle transit market in these neighborhoods. West side daily boardings exceed east side boardings for all

SR 520 Fixed Guideway alternatives, which indicates the relative size of the intra-west side HCT transit market compared to the intra-east side market.

East side boardings vary much less among SR 520 Fixed Guideway alternatives compared to the west side boardings, indicating that the intra-east side transit demand is not that sensitive to the chosen alignment since all the east side alignments serve the same major travel markets of Bellevue, Kirkland and Redmond. The alternatives with direct Downtown Bellevue connections had somewhat lower intra-east side boardings compared to those with a branch line to Bellevue, due to the higher number of transfers required for intra-east side trips between communities when there is no direct service to Bellevue.

In terms of boardings alone, Alternatives C1.1b-d west side alignments perform best, while Alternatives C1.1c-d east side alignments perform best. While Alternative C1.1d has the highest total daily HCT boardings, it has the lowest daily and PM peak period cross-lake ridership, due to longer travel times to Downtown Seattle. Alternative C1.1d has the longest west side alignment, mostly in tunnels, and therefore would be the most costly to construct. An Alternative such as C1.1c, which balances cross-lake ridership, west side/east side boardings, as well as cost, would be the preferred option to take forward to Multi-Modal Packaging as a representative alignment.

#### *2.3.2.2 SR 520 Bus Rapid Transit Alternatives*

There are no significant differences in total daily or west side boardings for the SR 520 BRT alternatives; the difference is in the east side boardings. This difference is primarily a result of the overall service concept. Alternative C1.2c, which has a trunk and feeder bus service concept on the east side, requires more transfers on the east side compared to the radial service concept of C1.2a and C1.2b and thus results in more daily boardings.

#### *2.3.2.3 I-90 Fixed Guideway Alternatives*

The I-90 corridor alternatives have lower east and west side boardings compared to the SR 520 alternatives, indicating that they are less attractive for intra-Seattle trips and trips between east side communities. However, comparing the model results for Alternatives C2.1b and C1.1a, which both have direct alignments between Downtown Seattle and Downtown Bellevue, the total daily boardings are about the same. This result shows that with similar connections to major transit markets, there is little difference between the I-90 and SR 520 corridors in terms of total daily boardings. The key difference between the two corridors is that the SR 520 Fixed Guideway alternatives will eventually require a new line between the University District and Downtown Seattle, which has the potential to directly service new west side transit markets in the University District, Wallingford, Fremont, Ballard, or Queen Anne. With the I-90 corridor alternatives, a new extension northwards from Downtown Seattle would be necessary to access these new markets.

#### *2.3.2.4 Mid-Lake Fixed Guideway Alternative*

The Mid-Lake Fixed Guideway alternative is expected to have the lowest daily boardings of all the lake crossing alternatives, primarily due to low east side transit boardings. This is a result of the Mid-Lake crossing alignment that does not directly serve transit demand between the South Bellevue/Factoria or Medina/Points areas and other east side communities.

## 2.4 TRAVEL TIME

### 2.4.1 Travel Time Forecasts

Table 2-5 is a summary indicating the forecasted range in travel times for three key origin-destination (O-D) pairs for the three HCT corridors. It can be seen that the travel times between Downtown Seattle and Downtown Bellevue or Redmond are similar for the SR 520 and I-90 corridors. Travel times between the University District are much faster with a SR 520 crossing. The Mid-Lake corridor has the fastest travel times between Downtown Seattle and the east side.

**Table 2-5. Travel Time Summary Table**

| | Range of Peak Period Travel Time (minutes) | | |
|---|---|---|---|
| **Corridor Alternative** | **Between Downtown Seattle and Downtown Bellevue** | **Between Downtown Seattle and Redmond** | **Between University District and Redmond** |
| C1: SR 520 Fixed Guideway Alternatives | 20-36 | 34-41 | 14-25 |
| C1: SR 520 Bus Rapid Transit Alternatives | 24-26 | 28-34 | 14-17 |
| C2: I-90 Fixed Guideway Alternatives | 20-23 | 36-40 | 38-45 |
| C3: Mid-Lake Fixed Guideway Alternative | 14 | 29 | 32 |

Table 2-6 provides a more detailed breakdown by individual alignment alternative, for a total of six O-D pairs. These six O-D pairs were chosen for comparative analysis of the alternatives to reflect major regional travel markets served by the HCT alternatives. In some cases, regular bus service would be required to complete the entire trip between O-D pairs. Note that the assumed routings between O-D pairs were developed to illustrate the differences between HCT alignments and were not necessarily the fastest routes.

**Table 2-6. Comparative Analysis of 2020 Peak Period Travel Times for HCT Passengers, for Selected Origin-Destination Pairs**

| | 2020 PM Peak Period Travel Times (min.) | | | | | |
|---|---|---|---|---|---|---|
| **From:** | **Bellevue Station** | **Bear Creek Station** | **Kirkland Station** | **Capitol Hill Station** | **McClellan Station** | **Bellevue Station** |
| **To:** | **University St. Station** | **Westlake Station** | **University District** | **Bellevue Station** | **Redmond Station** | **Seattle Center** |
| **SR 520 Fixed Guideway Alternatives** | | | | | | |
| C1.1a | **19.8** | 33.5 | 24.5 | 23.7 | 46.8 | 31.0 |
| C1.1b | 24.3 | 38.1 | 18.3 | 16.9 | 48.3 | 17.0 |
| C1.1c | 29.1 | 34.0 | 13.5 | 21.6 | 44.2 | 21.7 |
| C1.1d | 36.3 | 41.2 | 15.4 | 24.9 | 47.5 | 28.5 |
| *Average* | *27.4* | *34.2* | *17.9* | *21.8* | *46.7* | *24.6* |
| **SR 520 BRT Alternatives** | | | | | | |
| C1.2a | 26.1 | 33.5 | 13.9 | 21.2 | 43.0 | 39.0 |
| C1.2b | 23.8 | 27.5 | 16.8 | 25.1 | 40.8 | 35.0 |
| C1.2c | 25.0 | 30.0 | 16.8 | 25.9 | 45.0 | 35.0 |
| *Average* | *25.0* | *30.3* | *15.8* | *24.1* | *42.9* | *36.3* |
| **I-90 Fixed Guideway Alternatives** | | | | | | |
| C2.1a | 23.1 | 39.2 | 44.6 | 28.9 | 42.9 | 38.0 |
| C2.1b | 20.1 | 36.2 | 38.1 | 25.9 | 39.8 | 35.0 |
| *Average* | *21.6* | *37.7* | *41.4* | *27.4* | *41.4* | *36.5* |
| **Mid-Lake Fixed Guideway Alternative** | | | | | | |
| C3.1a | 13.9 | 29.3 | 31.9 | 19.7 | 33.6 | 29.0 |
| *Overall Average* | *24.1* | *34.3* | *24.4* | *23.4* | *43.2* | *31.0* |

Notes:
Top two fastest travel times are indicated in **bold** type for each O-D pair; averages are shown in *italics*.
Travel times were calculated in the direction indicated in the table.

The travel time estimates were based on vehicle run time estimates. For the Fixed Guideway alternatives, the run times were based on a spreadsheet model that considered acceleration and deceleration rates, speed constraints due to curves and average station dwell times of 20 seconds. BRT run times were developed in a similar manner, using model parameters appropriate for bus vehicle performance.

The estimates do not include walk times at either end of the trip. They also do not include the wait time for the first vehicle. Where a transfer would be required, a wait time of half the headway of the second vehicle was included, along with a minute for the transfer walk time. The estimates represent peak period travel times, for either the AM or PM peak periods.

Note that the forecasted travel times do not take into account the reliability of these average travel times as perceived by the user. The average travel time for passengers using Fixed Guideway systems or BRT in exclusive bus lanes would be far more consistent than average travel times using regular transit services that mix with other traffic, because in the latter case, vehicles would be subject to variability in travel times due to congestion/incident effects.

## 2.4.2 Comparison of Alternatives: Travel Time

### *2.4.2.1 SR 520 Fixed Guideway Alternatives*

Alternative C1.1a provides the quickest travel time between Downtown Bellevue and Downtown Seattle; this is not surprising, given that this alternative includes the most direct SR 520 alignment between these two travel markets. The SR 520 Fixed Guideway alternatives with the "inside loop" on the west side of Seattle (C1.1b and C1.1c) also offer the shortest times for trips between Seattle Center and Downtown Bellevue.

The difference in travel time for trips between Downtown Bellevue and Downtown Seattle for the four SR 520 Fixed Guideway alternatives illustrates the impact of the longer west side alignments which access new travel markets in the University District, Wallingford, Fremont, Ballard and Queen Anne neighborhoods. Alternatives C1.1b-d result in the second longest travel times for trips between Downtown Seattle and Downtown Bellevue. Implementation of the shorter, "inside" loop in Alternatives C1.1b and C1.1c adds approximately 4.5 minutes to the travel time when compared to C1.1a, while the longer, "outside" loop in Alternative C1.1d adds another 7.2 minutes to the trip, for a total of about 12 more minutes when compared to C1.1a.

Alternatives C1.1b-d offer faster travel times between the University and east side communities compared to Alternative C1.1a, which requires 6-11 more minutes for these trips as it lacks a direct connection to the University District so a transfer to a local city bus will be necessary at the Montlake Station. It is also likely that the travel times between the Wallingford, Fremont, Ballard and Queen Anne neighborhoods and Downtown Seattle are improved over Alternative C1.1a. However, Alternative C1.1d has the longest travel times for almost every regional O-D pair.

The SR 520 Fixed Guideway corridor alternatives in general result in the longest travel times for trips between the south end of Downtown Seattle and Kirkland/Redmond. In terms of travel time for trips between Downtown Seattle and east side communities, C1.1a is preferred for both its direct east and west side alignments, while C1.1d is the least preferred. For trips between the east side communities and the University District/west side neighborhoods, the west side alignments of C1.1b-d are preferred. The east side alignment in C1.1a-b serves trips between Downtown Bellevue and the University District trips faster, while the east side alignment in C1.1c-d serves trips between Kirkland/Redmond and the University District faster as they don't have to pass through Downtown Bellevue unnecessarily.

Further investigation into the size of the various travel markets and the overall impact on Person-Hours of Travel within the study area is warranted, rather than just relying on travel times alone to establish the preferred west side and east side alignments.

#### *2.4.2.2 SR 520 BRT Alternatives*

The SR 520 BRT alternatives, which employ exclusive bus lanes, are fastest for trips between Kirkland/Redmond and the University District, and between Redmond/Kirkland and Downtown Seattle. Trips between Downtown Seattle and Downtown Bellevue would generally be faster on the I-90 bus routes.

There is not much variation among travel times for the BRT alternatives. C1.2a provides better travel times for trips between the University District and east side town centers due to the crossing of the Montlake cut and service to the Central Line's Pacific Street station. However, this time savings is only 3 minutes, which is relatively minor, because of the assumption in Alternatives C1.2b and C1.2c that some BRT vehicles at the Montlake Station would be directed to the University District via city streets. Of course, this assumption depends on the availability of on-street capacity for BRT vehicles within the University District.

C1.2a would also provide better travel times between the east side town centers and points northward on or close to the Central Link line, which are not included in Table 2-6 above. However, C1.2b has better travel times compared to C1.2a for trips between Downtown Seattle and east side town centers (by about 4 to 6 minutes) as it provides a direct connection to Downtown Seattle without a transfer. Again, a more detailed investigation into the size of the various markets served and the total person-hours of travel in the study area is required to determine whether the direct University connection would be preferred over the direct Downtown Seattle connection, or whether including both connections would be the optimum solution.

When comparing travel times for C1.2b and C1.2c, the radial service concept results in about 2.5 minutes less travel time than the trunk/feeder concept between west side and east side major O-D pairs. C1.2b assumes an exclusive busway to Westlake Station while C1.2c assumes that BRT vehicles use downtown streets south of Denny Way, so transit patrons are subject to on-street congestion impacts which reduces travel time. Therefore, a BRT concept with a Westlake Intercept and radial service pattern would likely result in the fastest overall travel times for trips to/from Downtown Seattle. However, the high cost of constructing a Westlake Intercept and the inefficient transit operations inherent in a radial service concept should be balanced against the improved travel times and potentially higher ridership associated with this option.

#### *2.4.2.3 I-90 Fixed Guideway Alternatives*

The I-90 Fixed Guideway alternatives generally offer the fastest travel times between South Downtown Seattle and Redmond, and the second fastest travel times between Downtown Bellevue and Downtown Seattle. However, they have the longest travel times between Redmond

and Downtown Seattle, between Downtown Bellevue and Capitol Hill, and between Kirkland and the University District.

Alternative C2.1b, which bypasses Factoria, offers the fastest travel times for all major O-D pairs due to the directness of its alignment between Downtown Seattle and Downtown Bellevue and is clearly preferred from a travel time perspective.

#### *2.4.2.4 Mid-Lake Fixed Guideway Alternative*

Overall, the Mid-Lake Fixed Guideway alternative provides either the shortest or very competitive travel times for all regional O-D pairs, except between the University District and east side communities. In the latter case, transfers are required so travel times are longer than with the SR 520 alternatives with a direct connection to the University District (C1.1b, c and C1.2a). The Mid-Lake alternative performs well in terms of travel time due to it shorter length and direct link between Downtown Seattle and Downtown Bellevue.

## 2.5 SUMMARY OF CONCLUSIONS ON TRANSPORTATION PERFORMANCE

### 2.5.1 Overall

- 2020 Daily transit ridership across Lake Washington varies among alternatives but not significantly, ranging from a low of 46,000 to a high of 54,000 daily riders (two-way).

- 2020 PM Peak period ridership across Lake Washington varies among alternatives but was relatively consistent between alignment alternatives. It is estimated that a new HCT Trans-Lake service would result in total two-way transit ridership across Lake Washington between 17,000 and 21,000 during the 2020 PM Peak period of travel. Applying a typical transit peak hour factor of 0.43-0.45, this would result in about 7,300 to 9,500 passengers, two-way, using HCT during the peak hour.

- Reverse commute transit ridership during the PM Peak Period is expected to grow faster than peak direction travel across Lake Washington. Alternatives that better serve the reverse commute travel pattern typically result in higher cross-lake ridership.

- Average travel times for major trips in the region vary significantly between alternatives. Also, alternatives that require more transfers typically result in higher travel times for the same trip. In the Second Level Screening, the impact of travel time increases should be combined with the number of riders affected, through the use of a new measure, "Person-Hours of Travel". In this way, a better assessment of overall travel savings or delays due to various alignments can be made.

### 2.5.2 SR 520 Fixed Guideway Alternatives

#### *2.5.2.1 West Side Alignment*

- Generally, the SR 520 corridor alternatives perform slightly better than the other two corridors in attracting higher daily and PM Peak period cross-lake ridership because they can serve the University directly, have a second, northern connection to the Central Link line at Pacific Street and many of them serve additional new west side travel markets.

- Daily and west side transit boardings as well as daily cross-lake ridership are significantly impacted by the alignment chosen on the west side. The greater the number of new markets served, the higher the west side daily boardings. However, this intra-Seattle ridership is gained at the expense of longer trip times between Downtown Seattle and the east side communities. Once the west side alignment becomes too long (as in Alternative C1.1d), cross-lake ridership goes down. Intra-west side ridership gains should be balanced against other evaluation criteria, particularly cross-lake ridership and cost.

- The west side alignment which appears to balance most transportation performance criteria as well as cost is that included with Alternatives C1.1b and C1.1c, since higher cross-lake and west side ridership result, without incurring the costs of the longer west side alignment of C1.1d and not substantially increasing travel times.

#### *2.5.2.2 East Side Alignment*

- Daily and PM Peak period transit ridership across the lake and boardings on the east side of the lake are influenced by the directness of the alignment to Downtown Bellevue; the more direct the connection, the higher the ridership. However, these ridership gains are modest and should be balanced against other criteria, such as cost; for example, the high cost of the Clyde Hill Tunnel may not be justified by the relatively small cross-lake ridership gains anticipated with the direct connection to Downtown Bellevue.

- The SR 520 Fixed Guideway corridor alternative with the direct to Bellevue connection under Clyde Hill has better travel times for trips between Downtown Bellevue and the University District, and between Downtown Bellevue and Downtown Seattle and for travel within the east side. However, travel times for trips between Kirkland/Redmond and the University District and Downtown Seattle are slightly longer as passengers must travel through Downtown Bellevue unnecessarily.

- There is no clear preference for an east side SR 520 alignment from a transportation performance perspective alone. Other factors, particularly cost, should be considered.

### 2.5.3 SR 520 BRT Alternatives

- The SR 520 BRT alternatives result in very similar cross-lake ridership forecasts but different travel time characteristics and boarding patterns.

- The SR 520 BRT alternative with the Pacific Street intercept had slightly higher ridership, primarily because it provides better access to east side employment, via the connection to Central Link at Pacific Street. Terminating the BRT service at the Pacific Street terminal provides residents of Central and North Seattle more frequent transit service to/from the east side of the lake, resulting in somewhat higher cross-lake ridership in the off-peak direction.

- The differences between the BRT alternatives are relatively small, so other evaluation criteria must be considered in evaluating BRT alternatives. For example, the large capital investment for a new bus tunnel to either the Pacific Street or Westlake intercept must be considered, as must the feasibility of utilizing on-street capacity for regional BRT services in Downtown Seattle.

### 2.5.4 I-90 Fixed Guideway Alternatives

- Daily transit boardings across the lake and on the east side of the lake are influenced by the directness of the alignment to downtown Bellevue; the more direct the connection, the higher the number of daily boardings.

- Transportation performance is not substantially impacted by the Eastgate/Issaquah branch line.

- Compared to other lake crossing corridors, the I-90 corridor has good travel times to/from Downtown Seattle and Downtown Bellevue, similar travel times to Redmond but longer times to Kirkland, and between the University District and the east side communities.

- Alternative C1.2b is the clearly preferred alignment in the I-90 corridor based on transportation performance.

### 2.5.5 Mid-Lake Fixed Guideway Alternatives

- The Mid-Lake corridor performs well in terms of cross-lake PM peak period ridership but has slightly lower daily ridership than the other corridor alternatives. These results indicate that the Mid-Lake alternative is not as attractive to off-peak period or intra-west side/east-side travelers. The direct connection between Downtown Seattle and Downtown Bellevue excludes some potential transit markets that are directly served in the other SR 520 and I-90 corridor alternatives.

- Note that the major benefit expected with this alignment alternative, a significantly higher cross-lake ridership when compared to other alignments, did not materialize in the model forecasts.

- The Mid-Lake alternative has the best travel times to/from Downtown Seattle and east side urban centers.

- Other evaluation criteria should be reviewed in determining whether the Mid-Lake

crossing should be pursued, particularly costs and risks associated with a bored or submerged tunnel.

## 2.6 OPPORTUNITIES FOR ALTERNATIVE REFINEMENT

The next step in the project is to combine both HCT and highway improvements into representative multi-modal packages for more detailed analysis and evaluation in the Second Level Screening. To this end, the Project Team reviewed the Modal Analysis results and developed recommendations based on transportation performance, as noted below:

### 2.6.1 SR 520 Fixed Guideway Alternatives

- Drop the west side alignment of C1.1d from further consideration at this time, due to reduced transportation effectiveness compared to C1.1c and increased cost;

- Fine-tune the west side alignments of C1.1a and C1.1b, since these two alignments offer significant travel time and intra-west side ridership benefits, respectively. Investigate travel times/Person-Hours of Travel in more detail in the next stage of the project;

- If cost prohibitive, drop the east side alignment of C1.1a-b from further consideration at this time, since the benefits of a direct Bellevue connection may not outweigh the substantial costs and risks associated with the Clyde Hill tunnel;

- Fine-tune the east side alignment of C1.1c-d, since these alignments offer very similar benefits to C1.1a-b but at less cost. Investigate options to avoid/reduce/minimize impacts on Yarrow Bay. Investigate travel times/Person-Hours of Travel in more detail in the next stage of the project.

### 2.6.2 SR 520 BRT Alternatives

- Consider Alternative C1.2a, with the Pacific Street Intercept, as a possible interim phase and investigate the need and timing for a southwards extension to Downtown Seattle, due to potential capacity constraints on the Central Link line between the University District and Downtown Seattle;

- Investigate BRT operational issues in the University District and Downtown Seattle through more detailed analysis;

- Fine tune the west side and east side alignments of C1.2b and C1.2c;

- Consider reducing costs of BRT alternatives by having BRT vehicles share 3+ HOV lanes in the SR 520 corridor east of the University District rather than constructing exclusive busways throughout.

### 2.6.3 I-90 Fixed Guideway Alternatives

- Drop Alternative C2.1a from further consideration at this time, since the indirect Factoria alignment reduces cross-lake ridership and Issaquah can be well served by express bus with a transfer at South Bellevue Park-and-Ride;

- Fine-tune the east side alignment of Alternative C2.1b. Investigate options to avoid/reduce/minimize impacts on Mercer Slough.

### 2.6.4 Mid-Lake Fixed Guideway Alternative

- If cost prohibitive, drop the Mid-Lake Alternative C3.1a from further consideration at this time, since ridership forecasts are very similar or lower compared to the other two corridors which have alignment alternatives that cost less and have significantly less construction risk.

# 4. COST

## 4.1 PURPOSE

This chapter provides an overview of the initial capital cost estimating methods and results for the high capacity rail transit alternatives under consideration in the Trans-Lake Washington Project. The capital cost estimates provide a consistent basis for comparisons among representative HCT routes, but this method does not contain sufficient accuracy to support the development of project budgets. Even with the application of varying contingencies, estimates generated based on this preliminary sketch level yield accuracy levels in the range of plus 30 percent and minus 25 percent. In addition, the alternatives represent "full system" conditions. Shorter segments with lower costs could later be developed.

The conceptual capital cost estimates considered the full scope of the alternatives as initially defined, including the following major elements:

- High capacity transit guideway, including trackwork and allowances for special trackwork (e.g., crossovers).
- Related civil and traffic work (roadway and intersection improvements, traffic signals and gates, drainage, stormwater management, utility relocations).
- Rail transit stations, including architectural finishes (e.g., lighting, signage, landscaping, station furniture) and electrical/mechanical (e.g., elevators, escalators, ventilation).
- System elements for alignments and stations (e.g. power supply, train control, communications, fare collection).
- Operations and maintenance facilities (i.e., yard and shop).
- Light rail transit vehicles.
- Right-of-way, including relocation program and administrative and legal costs.
- Agency costs (e.g., environmental analysis, engineering, construction management, administration, etc.).

The cost estimating does not include

- Operating costs (utilities, labor).
- Improvements outside those described in the engineering documents (e.g., betterments).
- Environmental mitigation (e.g., wetlands, hazardous materials, or lidding, etc.).

Because this phase of the project does not involve detailed design documents, the estimators used design and construction contingencies to address cost elements that are known to exist but cannot be easily quantified. These contingencies reflect incomplete design and project staging information, uncertainties about the evolution of the design, and changes in construction market conditions. For example, the following contingencies are applied:

| **Project Component** | **Design Contingency** (percentage of extended costs) | **Construction Contingency** (percentage of extended costs) |
|---|---|---|
| Submerged Floating Tunnel | 50 percent | 25 percent |
| Floating/Movable Bridge | 35 percent | 15 percent |
| Tunnel Guideway & Stations | 35 percent | 15 percent |
| Aerial Guideway & Stations | 30 percent | 10 percent |
| At-Grade Guideway & Stations | 25 percent | 10 percent |
| Specialty Items | 35 percent | 10 percent |
| Vehicles & Maintenance Base | 15 percent | 10 percent |

## 4.2 SUMMARY OF COST FINDINGS

The HCT alternatives under consideration had a substantial range of capital costs, with the I-90 routes (C2) having costs of $2.6 to $3.2 billion, the SR 520 (C1) routes with $3.7 to $5.2 billion, and Mid-lake (C3) routes having the highest costs. These costs tend to reflect a fully extended system with 22 to 32 miles of HCT facilities. In many cases, less lengthy system options would be possible, carrying lower costs. However, some additional segments, particularly with the SR 520 routes connecting to Seattle, would be required for feasible long-range HCT system operations.

Because the alternatives are still at a planning level of definition, the cost opinions were viewed comparatively rather than as an indicator of Trans-Lake HCT affordability. Costs are summarized in Table 3-1. The costs shown involve broad assumptions about the design requirements for the facility and for related features. They also include large factors for contingency. All of the alternatives have potential for substantially changed costs if the facility is defined differently, particularly in terms of how transit and highway facilities are combined in a corridor.

## Table 3-1. Conceptual Capital Cost Estimates (Millions of 2001 Dollars)

| Alternative | HCT Facility Capital Cost | | | HCT Operations Capital Cost | | Total Capital Costs |
|---|---|---|---|---|---|---|
| | West Side | Lake Crossing | Eastside | Vehicles | Maintenance Base | |
| **C1: SR 520 Fixed-Guideway** | | | | | | |
| Alternative C1.1a: SR 520 Fixed-Guideway, Downtown Seattle – Bellevue – Kirkland/Redmond | $740 | $190 | $2,420 | $300 | $140 | $3.8 Billion |
| Alternative C1.1b: SR 520 Fixed-Guideway, Downtown Seattle – U District – Bellevue – Kirkland/Redmond | $1,840 | $190 | $2,420 | $340 | $140 | $4.9 Billion |
| Alternative C1.1c: SR 520 Fixed-Guideway, Downtown Seattle – U District – Kirkland/Redmond/Bellevue | $1,840 | $190 | $1,890 | $330 | $150 | $4.4 Billion |
| Alternative C1.1d: SR 520 Fixed-Guideway, Downtown Seattle – Ballard – U District – Kirkland/Redmond/Bellevue | $2,580 | $190 | $1,890 | $140 | $160 | $5.2 Billion |
| **C1: SR 520 Bus Rapid Transit** | | | | | | |
| Alternative C1.2a: SR 520 BRT, Radial Service Pattern, Pacific Street Intercept | $1,160 | $340 | $2,020 | $70 | $70 | $3.7 Billion |
| Alternative C1.2b: SR 520 BRT, Radial Service Pattern, Westlake Intercept | $2,230 | $340 | $2,020 | $80 | $80 | $4.8 Billion |
| Alternative C1.2c: SR 520 BRT, Trunk/Feeder Service Pattern, Direct Routing through Downtown Seattle | $1,630 | $340 | $2,020 | $70 | $70 | $4.1 Billion |
| **C2: I-90 Fixed-Guideway** | | | | | | |
| Alternative C2.1a: I-90 Fixed-Guideway, Downtown Seattle – Factoria – Issaquah/Bellevue – Kirkland/Redmond | $50 | $90 | $2,710 | $300 | $140 | $3.3 Billion |
| Alternative C2.1b: I-90 Fixed-Guideway, Downtown Seattle – Bellevue – Kirkland/Redmond | $50 | $90 | $2,090 | $260 | $140 | $2.7 Billion |
| **C3: Mid-Lake Fixed-Guideway** | | | | | | |
| Alternative C3.1a: Mid-Lake Fixed-Guideway, Downtown Seattle – Bellevue – Kirkland/Redmond | $620 | $1,040 (Submerged Floating Tunnel)<br>$1,340 (Deep tunnel) | $1,890 | $190 | $120 | $3.9 – 4.2 Billion |

Descriptions are consistent with the "Draft detailed definition of Hot Alternatives" refer to this report if more detail is required.

The BRT vehicles include 20% design contingency, which may not be necessary.

## Table 3-2. HCT Fixed Guideway Alternatives Conceptual Capital Cost Estimates (Millions of 2001 Dollars)

### Alternative C1.1a

| Alternative Components | Segment Description | Total Cost |
|---|---|---|
| **Segments** | | |
| A3.1 | Westlake Downtown terminus to SR 520 at west side of Lake Washington via Capitol Hill | $742.80 |
| B3 | SR 520 crossing of Lake Washington | $194.00 |
| C3.1 | SR 520 at east side of Lake Washington to Downtown Bellevue via Clyde Hill | $789.90 |
| C3.2.2 | South Kirkland to Northup on BNSF right-of-way | $146.60 |
| C3.2.3 | Northup to Bel-Red Road on BNSF right-of-way | $48.30 |
| F | South Kirkland Park-and-Ride to Totem Lake Mall terminus vis BNSF right-of-way | $492.40 |
| D1 | BNSF right-of-way at Bel-Red Road to SR 520 via median on Bel-Red Road to Overlake | $442.00 |
| E2 | Overlake to Redmond terminus via 148th Avenue NE corridor | $496.20 |
| **Sub Total** | | **$3,352.20** |
| **Vehicles** | | **$295.80** |
| **Sub Total** | | **$295.80** |
| | | |
| **Maintenance Base** | | |
| Facilities | | $107.70 |
| Grading | | $17.60 |
| ROW | | $11.90 |
| **Sub Total** | | **$137.20** |
| **Total** | | **$3,785.20** |
| **SAY (Million)** | | **$3,790** |

Table 3-2. HCT Fixed Guideway Alternatives Conceptual Capital Cost Estimates
(Millions of 2001 Dollars) (Continued)

## Alternative C1.1b

| Alternative Components | Segment Description | Total Cost |
|---|---|---|
| **Segments** | | |
| A3.2 | Westlake Downtown terminus to SR 520 at west side of Lake Washington via East Queen Anne and U-District | $1,842.00 |
| B3 | SR 520 crossing of Lake Washington | $194.00 |
| C3.1 | SR 520 at east side of Lake Washington to Downtown Bellevue via Clyde Hill | $789.90 |
| C3.2.2 | South Kirkland to Northup on BNSF right-of-way | $146.60 |
| C3.2.3 | Northup to Bel-Red Road on BNSF right-of-way | $48.30 |
| F | South Kirkland Park-and-Ride to Totem Lake Mall terminus vis BNSF right-of-way | $492.40 |
| D1 | BNSF right-of-way at Bel-Red Road to SR 520 via median on Bel-Red Road to Overlake | $442.00 |
| E2 | Overlake to Redmond terminus via 148th Avenue NE corridor | $496.20 |
| **Sub Total** | | **$4,451.40** |
| **Vehicles** | | **$336.40** |
| **Sub Total** | | **$336.40** |
| | | |
| **Maintenance Base:** | | |
| Facilities | | $113.40 |
| Grading | | $17.60 |
| ROW | | $11.90 |
| **Sub Total** | | **$142.90** |
| **Total** | | **$4,930.70** |
| **SAY (Million)** | | **$4,930** |

Table 3-2. HCT Fixed Guideway Alternatives Conceptual Capital Cost Estimates
(Millions of 2001 Dollars) (Continued)

| AlternativeC1.1c | | |
|---|---|---|
| **Alternative Components** | **Segment Description** | **Total Cost** |
| **Segments** | | |
| A3.2 | Westlake Downtown terminus to SR 520 at west side of Lake Washington via East Queen Anne and U-District | $1,842.00 |
| B3 | SR 520 crossing of Lake Washington | $194.00 |
| C3.2.1 | SR 520 at east side of Lake Washington to South Kirkland Park-and-Ride | $165.20 |
| C3.2.2 | South Kirkland to Northup on BNSF right-of-way | $146.60 |
| C3.2.3 | Northup to Bel-Red Road on BNSF right-of-way | $48.30 |
| C3.2.4 | Bel-Red Road to Downtown Bellevue terminus | $359.00 |
| F | South Kirkland Park-and-Ride to Totem Lake Mall terminus vis BNSF right-of-way | $492.40 |
| D2 | Northup to Overlake via SR 520 corridor | $379.10 |
| E1 | Overlake to Redmond terminus via SR 520 corridor | $295.90 |
| **Sub Total** | | **$3,922.50** |
| **Vehicles** | | **$330.60** |
| **Sub Total** | | **$330.60** |
| | | |
| **Maintenance Base** | | |
| Facilities | | $113.40 |
| Grading | | $17.60 |
| ROW | | $11.90 |
| **Sub Total** | | **$142.90** |
| **Total** | | **$4,396.00** |
| **SAY (Million)** | | **$4,400** |

Table 3-2. HCT Fixed Guideway Alternatives Conceptual Capital Cost Estimates
(Millions of 2001 Dollars) (Continued)

| Alternative C1.1d | | |
|---|---|---|
| **Alternative Components** | **Segment Description** | **Total Cost** |
| **Segments** | | |
| A3.3 | Westlake Downtown terminus to SR 520 at west side of Lake Washington via West Queen Anne, Ballard, Wallingford and U-District | $2,581.00 |
| B3 | SR 520 crossing of Lake Washington | $194.00 |
| C3.2.1 | SR 520 at east side of Lake Washington to South Kirkland Park-and-Ride | $165.20 |
| C3.2.2 | South Kirkland to Northup on BNSF right-of-way | $146.60 |
| C3.2.3 | Northup to Bel-Red Road on BNSF right-of-way | $48.30 |
| C3.2.4 | Bel-Red Road to Downtown Bellevue terminus | $359.00 |
| F | South Kirkland Park-and-Ride to Totem Lake Mall terminus vis BNSF right-of-way | $492.40 |
| D2 | Northup to Overlake via SR 520 corridor | $379.10 |
| E1 | Overlake to Redmond terminus via SR 520 corridor | $295.90 |
| **Sub Total** | | **$4,661.50** |
| **Vehicles** | | **$411.80** |
| **Sub Total** | | **$411.80** |
| | | |
| **Maintenance Base** | | |
| Facilities | | $124.70 |
| Grading | | $17.60 |
| ROW | | $11.90 |
| **Sub Total** | | **$154.20** |
| **Total** | | **$5,227.50** |
| **SAY (Million)** | | **$5,230** |

Table 3-2. HCT Fixed Guideway Alternatives Conceptual Capital Cost Estimates
(Millions of 2001 Dollars) (Continued)

| **Alternative C1.2a** | |
|---|---|
| **Alternative Components** | **Total Cost** |
| **Roadway Improvements** | |
| University District through Montlake to Lake Washington | $1,160,000,000 |
| Lake Washington crossing | $340,000,000 |
| Lake Washington along SR 520 then into downtown Bellevue | $640,000,000 |
| Downtown Bellevue to Overlake | $410,000,000 |
| Overlake to Redmond | $410,000,000 |
| SR 520 to Totem Lake | $560,000,000 |
| **Sub Total** | **$3,520,000,000** |
| | |
| **BRT Vehicles and Maintenance Base** | |
| BRT Vehicles | $70,000,000.00 |
| Maintenance Base | $70,000,000.00 |
| **Total** | **$3,660,000,000** |

| **Alternative C1.2b** | |
|---|---|
| **Alternative Components** | **Total Cost** |
| **Roadway Improvements** | |
| New BRT terminal at Westlake through Montlake to Lake Washington | $2,230,000,000 |
| Lake Washington crossing | $340,000,000 |
| Lake Washington along SR 520 then into downtown Bellevue | $640,000,000 |
| Downtown Bellevue to Overlake | $410,000,000 |
| Overlake to Redmond | $410,000,000 |
| SR 520 to Totem Lake | $560,000,000 |
| **Sub Total** | **$4,590,000,000** |
| | |
| **BRT Vehicles and Maintenance Base** | |
| BRT Vehicles | $80,000,000.00 |
| Maintenance Base | $80,000,000.00 |
| **Total** | **$4,750,000,000** |

Table 3-2. HCT Fixed Guideway Alternatives Conceptual Capital Cost Estimates
(Millions of 2001 Dollars) (Continued)

| **Alternative C1.2c** | |
|---|---|
| **Alternative Components** | **Total Cost** |
| **Roadway Improvements** | |
| Street access at Westlake through Montlake to Lake Washington | $1,630,000,000 |
| Lake Washington crossing | $340,000,000 |
| Lake Washington along SR 520 then into downtown Bellevue | $640,000,000 |
| Downtown Bellevue to Overlake | $410,000,000 |
| Overlake to Redmond | $410,000,000 |
| SR 520 to Totem Lake | $560,000,000 |
| **Sub Total** | **$3,990,000,000** |
| | |
| **BRT Vehicles and Maintenance Base** | |
| BRT Vehicles | $70,000,000.00 |
| Maintenance Base | $70,000,000.00 |
| **Total** | **$4,130,000,000** |

Note: The conceptual cost estimates for the BRT alternatives were developed using a methodology updated from highway cost estimating practices. At this stage of alternative development, the BRT option was considered more similar to separated HOV facilities on a highway than to a fixed-guideway facility such as light rail.

Table 3-2. HCT Fixed Guideway Alternatives Conceptual Capital Cost Estimates
(Millions of 2001 Dollars) (Continued)

| **Alternative C2.1a** | | |
|---|---|---|
| **Alternative Components** | **Segment Description** | **Total Cost** |
| **Segments** | | |
| A1 | Downtown Seattle transit tunnel at International Station to I-90 at west side of Lake Washington | $46.00 |
| B1 | I-90 crossing of Lake Washington, including floating bridge, Mercer Island section and East Channel Bridge | $85.70 |
| C1.2.1 | I-90 at east side of Lake Washington to Factoria via I-90 corridor | $130.00 |
| C1.2.2 | Factoria to Downtown Bellevue via Richards Road and Lake Hills Connector | $738.50 |
| C3.2.2 | South Kirkland to Northup on BNSF right-of-way | $146.60 |
| C3.2.3 | Northup to Bel-Red Road on BNSF right-of-way | $48.30 |
| F | South Kirkland Park-and-Ride to Totem Lake Mall terminus vis BNSF right-of-way | $492.40 |
| D1 | BNSF right-of-way at Bel-Red Road to SR 520 via median on Bel-Red Road to Overlake | $442.00 |
| E1 | Overlake to Redmond terminus via SR 520 corridor | $295.90 |
| G | Extension from Richards Road to Issaquah via I-90 | $422.70 |
| **Sub Total** | | **$2,848.10** |
| **Vehicles** | | **$301.60** |
| **Sub Total** | | **$301.60** |
| | | |
| **Maintenance Base** | | |
| Facilities | | $107.70 |
| Grading | | $17.60 |
| ROW | | $11.90 |
| **Sub Total** | | **$137.20** |
| **Total** | | **$3,286.90** |
| **SAY (Million)** | | **$3,290** |

Table 3-2. HCT Fixed Guideway Alternatives Conceptual Capital Cost Estimates
(Millions of 2001 Dollars) (Continued)

| **Alternative C2.1b** | | |
|---|---|---|
| **Alternative Components** | **Segment Description** | **Total Cost** |
| **Segments** | | |
| A1 | Downtown Seattle transit tunnel at International Station to I-90 at west side of Lake Washington | $46.00 |
| B1 | I-90 crossing of Lake Washington, including floating bridge, Mercer Island section and East Channel Bridge | $85.70 |
| C1.1 | I-90 at east side of Lake Washington to Downtown Bellevue and Bel-Red Road/BNSF right-of-way via Bellevue Way and 112th Avenue | $673.50 |
| C3.2.2 | South Kirkland to Northup on BNSF right-of-way | $146.60 |
| C3.2.3 | Northup to Bel-Red Road on BNSF right-of-way | $48.30 |
| F | South Kirkland Park-and-Ride to Totem Lake Mall terminus vis BNSF right-of-way | $492.40 |
| D1 | BNSF right-of-way at Bel-Red Road to SR 520 via median on Bel-Red Road to Overlake | $442.00 |
| E1 | Overlake to Redmond terminus via SR 520 corridor | $295.90 |
| **Sub Total** | | **$2,230.40** |
| **Vehicles** | | **$261.00** |
| **Sub Total** | | **$261.00** |
| | | |
| **Maintenance Base** | | |
| Facilities | | $107.70 |
| Grading | | $17.60 |
| ROW | | $11.90 |
| **Sub Total** | | **$137.20** |
| **Total** | | **$2,628.60** |
| **SAY (Million)** | | **$2,630** |

Table 3-2. HCT Fixed Guideway Alternatives Conceptual Capital Cost Estimates
(Millions of 2001 Dollars) (Continued)

| Alternative C3.1a | | | |
|---|---|---|---|
| **Alternative Components** | **Segment Description** | **Total Cost** | |
| **Segments** | | **Floating Tunnel** | **Deep Tunnel** |
| A2 | Downtown Seattle transit tunnel at International District Station to Howell Park area on west side of Lake Washington | $618.30 | $618.30 |
| B2 | Mid-Lake crossing of Lake Washington from Howell Park area to Medina | $1,037.10 | $1,345.40 |
| C2 | From east side of Mid-Lake crossing to Downtown Bellevue | $468.90 | $468.90 |
| C3.2.2 | South Kirkland to Northup on BNSF right-of-way | $146.60 | $146.60 |
| C3.2.3 | Northup to Bel-Red Road on BNSF right-of-way | $48.30 | $48.30 |
| F | South Kirkland Park-and-Ride to Totem Lake Mall terminus vis BNSF right-of-way | $492.40 | $492.40 |
| D1 | BNSF right-of-way at Bel-Red Road to SR 520 via median on Bel-Red Road to Overlake | $442.00 | $442.00 |
| E1 | Overlake to Redmond terminus via SR 520 corridor | $295.90 | $295.90 |
| **Sub Total** | | **$3,549.50** | **$3,857.80** |
| **Vehicles** | | **$185.60** | **$185.60** |
| **Sub Total** | | **$185.60** | **$185.60** |
| | | | |
| **Maintenance Base** | | | |
| Facilities | | $90.70 | $90.70 |
| Grading | | $17.60 | $17.60 |
| ROW | | $11.90 | $11.90 |
| **Sub Total** | | **$120.20** | **$120.20** |
| **Total** | | **$3,855.30** | **$4,163.60** |
| **SAY (Million)** | | **$3,860** | **$4,160** |

## DEFINITIONS

| | |
|---|---|
| Conceptual Cost Estimate | Order of magnitude cost estimate used for comparative purposes. |
| Unit Cost | Historical cost data for individual scope elements that comprise *composite unit prices*. |
| Composite Unit Price | Generalized cost estimate for typical alignment cross-sections, station configurations, and other facilities. Composite unit prices are expressed in terms of units of measure (e.g., route foot, track foot, square foot, each) that correspond to *quantity take-offs.* |
| Quantity Take-Off | Quantitative description of transit alternatives in terms of units established for *composite unit prices*. |
| Extended Cost | Product of composite unit price and the quantity take-off. |
| Design Contingency | Factor applied to *extended cost* to address the general nature of composite unit price and uncertainty of specific project details. |
| Construction Costs | Cost to construct and procure scope elements, including maintenance and storage facilities, revenue vehicles, parts, and equipment. Construction costs are computed as the product of *extended costs* and corresponding *design contingency* factors. |
| Construction Contingency | Budget allowance put in place to cover the cost of unforeseen conditions that may arise during construction, computed as a percentage of *construction costs.* |
| Revenue Vehicles | Defined as articulated low floor light rail transit (LRT) vehicles specified for the Central Link project. |
| Right-of-Way Costs | Property acquisition cost, including relocation programs and related administration and legal fees. |
| Agency Costs | Costs borne by the agency/agencies that sponsor the delivery of the project. Agency costs, also known as soft costs, include administration, environmental analyses, engineering, design support during construction, third party coordination, and construction management. Agency costs are estimated as a percentage of construction costs. |
| Capital Costs | Sum of construction costs, construction contingency, right-of-way costs, vehicles, and agency costs. |

| | |
|---|---|
| HCT Alternative Costs | Capital cost estimate for the full scope of each HCT alternative, including vehicles and the maintenance base. |
| Segment Costs | Capital cost estimate for individual alignment segments that comprise each HCT alternative. Segment costs do not include vehicle and maintenance base costs. |
| Operating/Maintenance Costs | Costs associated with the operation of the transit system, including labor and consumables (e.g., energy) expended for operations and maintenance. Operating and maintenance costs are expressed in terms of annual costs projected for full operations of a given high capacity transit alternative. |

## ACRONYMS

| | |
|---|---|
| ADA | Americans with Disabilities Act |
| BCI | Building Cost Index |
| CPI | Consumer Price Index |
| FICA | Federal Insurance Contributions Act |
| FUI | Federal Unemployment Insurance |
| HCT | High Capacity Transit |
| LRT | Light Rail Transit |
| LRV | Light Rail Vehicle |
| ROW | Right-of-Way |
| ROWI | Right-of-Way Index (per Sound Transit) |
| ST | Sound Transit |
| SUI | State Unemployment Insurance |
| WSDOT | Washington State Department of Transportation |